PATENT ABSTRACTS OF JAPAN

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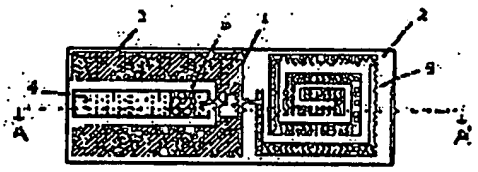
(54) WIRING BOARD

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the inductance precision of an inductor formed in a bias circuit, further, to easily control inductance value and to suppress stray capacitance to a minimum, in a wiring board suitable for semiconductor laser module, with which the data of large capacity can be communicated at a high speed by increasing a bit rate.
SOLUTION: A mounting part for a semiconductor laser device 1, an impedance matching circuit for taking impedance match of an input signal to the semiconductor laser device 1 and the bias circuit for applying bias voltage to the semiconductor laser device 1 are formed on the upper surface of an insulated substrate 2, and a ground electrode 7 is formed on a portion facing the impedance matching circuit on the lower surface of the insulated substrate 2.

(a)



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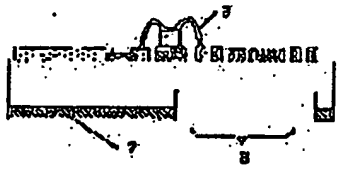

LEGAL STATUS

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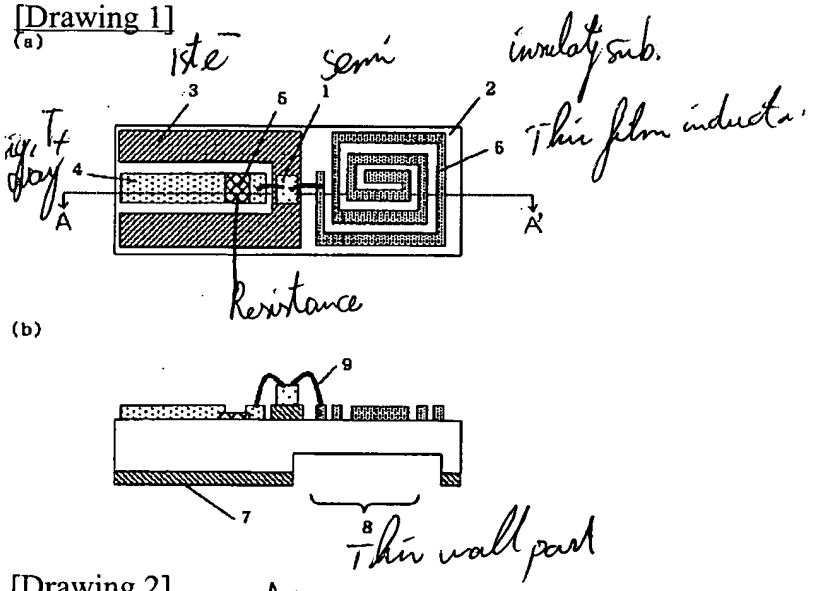
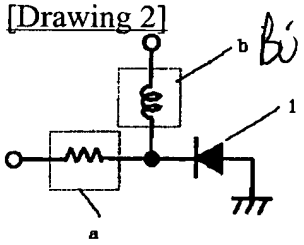
DRAWINGS

[Drawing 1]



[Drawing 2]



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CLAIMS

[Claim(s)]
[Claim 1] The wiring substrate characterized by forming the loading section of a semiconductor laser component, the impedance matching circuit for taking the impedance matching of the input signal to said semiconductor laser component, and the bias circuit for impressing bias voltage to said semiconductor laser component in the top face of an insulating substrate, and forming the earth electrode in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate.
[Claim 2] It is the wiring substrate according to claim 1 characterized by the part of said insulating substrate in which said earth electrode is formed only in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate, said bias circuit contains the thin film inductor pattern in, and this thin film inductor pattern was formed being thinner than others.

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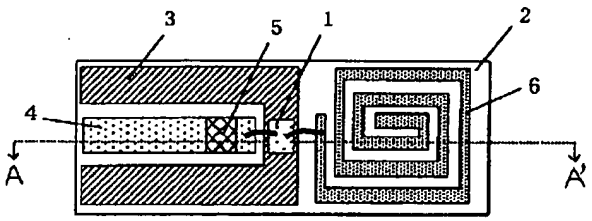
Drawing selection Representative drawing

(a)



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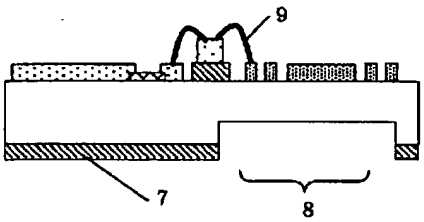

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a wiring substrate suitable as submounting in which the semiconductor laser component used for a semiconductor laser module is carried.
[0002]
[Description of the Prior Art] Conventionally, in an optical communication type, it is used in order for a semiconductor laser module to carry out electric - light conversion of the electric data signal which should be transmitted and to transmit to an optical fiber etc. as a lightwave signal, and a thing with the bit rate of the data communication exceeding 1G (G) bits per second (bps) is used increasingly widely.
[0003] An example of the electrical equivalent circuit of the semiconductor laser component periphery of a semiconductor laser module is shown in drawing 2 . In drawing 2 , the impedance matching circuit for adjusting the impedance of the driving signal (AC signal) with which 1 is inputted into a semiconductor laser component and a is inputted into a semiconductor laser component, and b are bias circuits which impress bias voltage to a semiconductor laser component, and lead to DC (direct current) drive power source for carrying out an excitation oscillation.
[0004] From DC drive power source, DC drive current goes into the semiconductor laser component 1 via bias circuit b, and the semiconductor laser component 1 carries out the excitation oscillation of the semiconductor laser module. Next, a RF signal is inputted into the semiconductor laser component 1 via the impedance matching circuit a, and the modulated lightwave signal is sent.
[0005] Here, if the high frequency signal inputted via the impedance matching circuit a goes into DC drive power source through bias circuit b, since supply voltage will become unstable and the oscillation of a semiconductor laser component will become unstable as a result, the stable communication link cannot be performed. For this reason, the inductor considered so that a RF signal might not go into DC drive power source is prepared in bias circuit b. As for this inductor, nothing, a winding coil, a laminating chip inductor, etc. are used in a role of the so-called choke coil.
[0006] If the semiconductor laser component 1 carries out an excitation oscillation, since it will generate heat to coincidence, the semiconductor laser component 1 is mounted in submounting which consists of a ceramic substrate with the high heat conductivity etc., and this submounting is connected to the heat sink which consists of a Cu-W alloy etc., a PERUCHIE cooler, etc. so that this heat may be missed efficiently and the semiconductor laser component 1 may be maintained at fixed temperature.
[0007] In recent years, the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed is examined by the optical-communication field. Forming the impedance matching circuit a in submounting which mounts the semiconductor laser component 1 as the one technique is examined. The impedance matching circuit a consists of signal-transmission ways, such as a microstrip line and a KOPURENA track, and a resistance element for adjustment, and, generally the characteristic impedance of a signal-transmission way is 50ohms. And the characteristic impedance of a signal-transmission way and the impedance of a semiconductor laser component in a desired frequency band are adjusted by changing thickness, such as line breadth of a signal-transmission way, and a ceramic substrate of submounting, etc., and setting up a circuit constant appropriately. Moreover, the load of the semiconductor laser component 1 is about several ohms, and it usually adjusts the resistance of the resistance element for adjustment so that the impedance of the series connection of the semiconductor laser component 1 and the resistance element for adjustment may have consistency in the characteristic impedance of a signal-transmission way.
[0008] An inductance, stray capacity, etc. which the die length of the bonding wire linked to a semiconductor laser component can be shortened, and have big effect on propagation of a high frequency signal by forming the impedance matching circuit a in the top face of the insulating substrate which makes submounting and which are produced by the

bonding wire can be stopped to the minimum. Furthermore, since the impedance matching circuit a and submounting are really formed, the components mark to mount can become fewer and the small semiconductor laser module with which mounting cost was reduced can be constituted.

[0009]

[Problem(s) to be Solved by the Invention] However, in order to be stabilized and to perform the high-speed communication link with the bit rate exceeding about 2.4Gbps, there was a problem that it was inadequate just to improve the impedance matching circuit a. That is, it is because it is impossible to prevent effectively that the frequency of the high frequency signal inputted into semiconductor laser becomes higher with increase of a bit rate, and a high frequency signal flows into DC drive power source by the inductor (choke coil) of bias circuit b. When the RF signal flowed into DC drive power source, supply voltage became unstable, the oscillation of semiconductor laser also became unstable as a result, and there was a problem that it could not communicate with a higher bit rate.

[0010] Although the inductor component was exchanged and the inductance value was adjusted to the optimal thing so that it might generally function as a choke coil on the frequency to be used, there was a problem that the adjustment was difficult, by the semiconductor laser module exceeding 2.4Gbps.

[0011] Furthermore, the inductor components used for bias circuit b were small components, and since they needed to mount these with a sufficient location precision and needed to assemble a semiconductor laser module, workability is bad, the yield did not go up but they also had the problem of forming high cost.

[0012] Therefore, this invention is completed in view of the above-mentioned situation, and the purpose is a wiring substrate suitable as an object for submounting of a semiconductor laser module which is stabilized and performs the high-speed communication link of the bit rate exceeding about 2.4Gbps, and is to offer what really formed the impedance matching circuit and the bias circuit by thin film coating technology.

[0013]

[Means for Solving the Problem] The wiring substrate of this invention is characterized by forming the loading section of a semiconductor laser component, the impedance matching circuit for taking the impedance matching of the input signal to said semiconductor laser component, and the bias circuit for impressing bias voltage to said semiconductor laser component in the top face of an insulating substrate, and forming the earth electrode in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate.

[0014] By the above-mentioned configuration, since this invention is the wiring substrate which really formed the loading section, impedance matching circuit, and bias circuit of a semiconductor laser component in the top face of an insulating substrate, it can shorten the bonding wire which connects a semiconductor laser component and an impedance matching circuit, and the bonding wire which connects a semiconductor laser component and a bias circuit. Consequently, the effect of the inductance by the bonding wire which is easy to affect a high frequency signal, or stray capacity can be suppressed to the minimum. Therefore, it will become suitable as submounting which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in submounting, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be produced.

[0015] In this invention, preferably, said earth electrode is formed only in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate, said bias circuit contains the thin film inductor pattern, and it is characterized by the part of said insulating substrate in which this thin film inductor pattern was formed being thinner than others.

[0016] By the above-mentioned configuration, since this invention forms the thin film inductor pattern with a sufficient precision by the photolithography method etc., it can do the small thing of the variation in an inductance value. Furthermore, since the part of an insulating substrate in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern was formed is thinner than others and space with air with small specific inductive capacity is formed in the insulating substrate directly under a thin film inductor pattern of an insulating substrate, an earth electrode can stop small the stray capacity produced with a thin film inductor pattern. Although it is possible to thicken thickness of the whole insulating substrate as another means which makes stray capacity small, since it is decided that it will be that the thickness of an insulating substrate makes 50 ohms adjust the characteristic impedance of the signal-transmission way of an impedance matching circuit, in order to make stray capacity of a bias circuit small, thickness of the whole insulating substrate cannot be thickened.

[0017] Adjustment variation can be made small and a thin film inductor pattern can adjust it while wirebonding of it can be carried out anywhere and it can adjust an inductance value easily, if it is the top face of a thin film inductor

pattern since it is formed in the top face of an insulating substrate with the thin film.

[0018] Thus, an inductance value can be adjusted with a sufficient precision, and since it becomes the wiring substrate which stopped stray capacity, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.

[0019]

[Embodiment of the Invention] The wiring substrate of this invention is explained below at a detail. It is a sectional view [in / (a) of drawing 1 , and / in (b) / the A-A' line of (a)]. [the plan of the wiring substrate of this invention] The first earth electrode with which the semiconductor laser component with which 1 was mounted in the wiring substrate, and 2 were formed in the insulating substrate, and 3 was formed in the top face, The thin film inductor pattern with which the signal-transmission way where 4 constitutes an impedance matching circuit, and 5 constitute the resistance element for adjustment, and 6 constitutes a bias circuit, the second earth electrode with which 7 was formed in the inferior surface of tongue, and 8 are the thin-walled part of an insulating substrate 2, and a bonding wire to which 9 changes from Au etc.

[0020] In addition, the loading section of the semiconductor laser component 1 is equivalent to the part by the side of the thin film inductor pattern 6 of the first earth electrode 3.

[0021] As for the insulating substrate 2 of this invention, it is desirable that consist of at least one sort in the nature sintered compact of an aluminum oxide (aluminum 2O3), the nature sintered compact of alumimium nitride (AlN), the nature sintered compact of silicon carbide (SiC), a crystallized glass sintered compact, and the nature sintered compact of silicon nitride (Si3N4), and especially thermal conductivity consists of the nature sintered compact of alumimium nitride of 40 or more W/m-K, the nature sintered compact of silicon carbide, and the nature sintered compact of silicon nitride.

[0022] The second earth electrode 7 by which covering formation is carried out on the inferior surface of tongue of the first earth electrode 3 by which covering formation is carried out on the top face of an insulating substrate 2, the signal-transmission way 4, the resistance element 5 for adjustment, the inductor pattern 6, and an insulating substrate 2 Do by one or more sorts of thin film forming methods, such as vacuum deposition, the sputtering method, a CVD method, and plating. Pattern processing of the first earth electrode 3, signal-transmission way 4, resistance element 5 for adjustment, and thin film inductor pattern 6 is carried out by the photolithography method, the etching method, the lift-off method, etc.

[0023] The first earth electrode 3, signal-transmission way 4, thin film inductor pattern 6, and second earth electrode 7 consist of a thin film of a three-tiered structure with which the laminating of for example, an adhesion metal layer, a diffusion prevention layer, and the initiative body whorl was carried out one by one. Here, an adhesion metal layer is the point of adhesion with the insulating substrate 2 which consists of the ceramics etc., and is good to consist of at least one sort in Ti, Cr, Ta, Nb, nickel-Cr alloy, or Ta2N etc. The thickness of an adhesion metal layer has good about 0.01-0.2 micrometers. In less than 0.01 micrometers, if sticking firmly becomes difficult and it exceeds 0.2 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation.

[0024] A diffusion prevention layer is good to consist of at least one sort in Pt, Pd, Rh, Ru, nickel, a nickel-Cr alloy, or a Ti-W alloy, when preventing the counter diffusion of an adhesion metal layer and an initiative body whorl. The thickness of a diffusion prevention layer has good about 0.05-1 micrometer, and the defect of a pinhole etc. occurs and it stops easily being able to achieve the function as a diffusion prevention layer in less than 0.05 micrometers. If it exceeds 1 micrometer, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Since adhesion can also be secured when using a nickel-Cr alloy for a diffusion prevention layer, it is also possible to exclude an adhesion metal layer.

[0025] Furthermore, the thickness of the initiative body whorl which consists of Au, Cu, nickel, Ag, etc. with low resistance has good about 0.1-5 micrometers. In less than 0.1 micrometers, if it is in the inclination for electric resistance to become large and exceeds 5 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Moreover, as for Au, it is desirable to form thinly in respect of low-cost-izing with noble metals, since it is expensive. Since Cu tends to oxidize, it is good on it to cover the protective coat which consists of nickel and Au.

[0026] An insulating substrate 2 is made to flow through the first earth electrode 3 formed in the top face of an insulating substrate 2, and the second earth electrode 7 formed in the inferior surface of tongue of an insulating substrate 2 through the metallizing pattern formed in an open hole (through hole), the beer hall where the conductive ingredient was embedded, axle-pin-rake rhe SHON, and a side face, and it may be made into same electric potential so that the RF signal passing through an impedance matching circuit may be transmitted good on the other hand.

[0027] The resistance element 5 for adjustment is formed with Ta2N, a nickel-Cr alloy, and an ingredient with the high

specific.resistance of TaSiO2 grade. The thickness of the resistance element 5 for adjustment has good about 0.005-0.2 micrometers, and it becomes difficult in less than 0.005 micrometers for resistance to become easy to change under the effect by the surface roughness of an insulating substrate 2 a lot, and to make variation in resistance small. If it exceeds 0.2 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Resistance can also be finely tuned with laser trimming etc.

[0028] Although the thin film inductor patterns 6 may be used as what kind of pattern as long as they are a MIANDA pattern, a spiral (curled form) pattern, etc. and are patterns which an inductance produces, they are suitable from the ability of a spiral pattern to enlarge an inductance value more. Furthermore, two or more electrodes for wirebonding may be prepared in the top face of the thin film inductor pattern 6 so that an inductor track may be made for a long time or short and an inductance value can be adjusted by the bonding of wires, such as Au. The wiring width of face of the thin film inductor pattern 6 has desirable about 5-200 micrometers, and wiring becomes easy to go out on the way with the irregularity of an insulating substrate 2 in less than 5 micrometers. If it exceeds 200 micrometers, when really forming in a wiring substrate, while having suitable magnitude, it becomes difficult to form a thin film inductor pattern with sufficient inductance value.

[0029] Moreover, when the thin film inductor pattern 6 is a spiral pattern, an inductance value can be finely tuned by carrying out thinning of the periphery side, such as the outermost periphery, opening spacing in the thin line section, and preparing two or more wirebonding electrodes in the direction of a track at it. Thereby, an inductance value is controllable with high precision. Moreover, stray capacity produced to the thin film inductor pattern 6 can be made still smaller by preparing the thin line section.

[0030] The thin-walled part 8 of an insulating substrate 2 can form the second earth electrode 7 and insulating substrate 2 with a diamond blade etc. first by carrying out cutting removal to the middle of the thickness direction of an insulating substrate 2 after forming the second earth electrode 7 in the whole inferior-surface-of-tongue surface of an insulating substrate 2. The thickness of the insulating substrate 2 of a thin-walled part 8 has the desirable range of 1 / 3 - 4/5 of the thickness of an insulating substrate 2, and less than in 1/3, in case a wiring substrate is mounted in a semiconductor laser module, it becomes easy to be divided from a thin-walled part 8. When it exceeds four fifths, it becomes impossible to fully stop the stray capacity generated to the thin film inductor pattern 6. Specifically, the thickness of an insulating substrate 2 is about 0.2-2mm. Moreover, the cross-section configuration of the edge of a thin-walled part may be made into a taper configuration which spreads toward the inferior-surface-of-tongue side of an insulating substrate 2, without making it perpendicular to a principal plane.

[0031] This invention is a wiring substrate which is used suitable for a semiconductor laser module and which really formed the impedance matching circuit and the bias circuit in this way, and since the top face of the insulating substrate 2 which consists of ceramics etc. is adjoined by thin film coating technology and the loading section of an impedance matching circuit, a bias circuit, and a semiconductor laser component is formed in it, the die length of the bonding wire 9 which connects them can be shortened extremely. The inductance and stray capacity of a bonding wire 9 which affect transmission of a high frequency signal can be stopped by this to the minimum, and it will become suitable as a wiring substrate which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in a wiring substrate, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be constituted.

[0032] Furthermore, in this invention, since the thin film inductor pattern 6 is contained in a bias circuit and the thin film inductor pattern 6 is formed with a sufficient precision by the photolithography method etc., the small thing of the variation in an inductance value is made. Furthermore, preferably, since the part of an insulating substrate 2 in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate 2, and the thin film inductor pattern 6 was formed is thinner than others, an earth electrode 7 can stop small the stray capacity produced with the thin film inductor pattern 6. Furthermore, since it is formed in the top face of an insulating substrate 2 with the thin film, if the thin film inductor pattern 6 is the top face of the thin film inductor pattern 6, wirebonding of it can be carried out anywhere, as a result, it can adjust an inductance value easily, and can make adjustment variation small and can adjust it.

[0033] Thus, an inductance value can be adjusted with a sufficient precision, and since it becomes the wiring substrate which stopped stray capacity to the minimum, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.

[0034] In addition, this invention is not limited to the gestalt of the above-mentioned implementation, and making various change within limits which do not deviate from the summary of this invention does not interfere at all. For example, it is good also as a wiring substrate which really formed the temperature sensor which consists of Pt which

prepares the electrode pad which mounts the thermistor for measuring the temperature of the semiconductor laser component 1 in the top face of an insulating substrate 2, or measures the temperature of the semiconductor laser component 1. Moreover, the field in which the lens of the shape of a ball which condenses the lightwave signal oscillated from the semiconductor laser component 1 is installed may be prepared. Moreover, although one thin film inductor pattern 6 is formed in drawing 1 , more than one may be prepared and you may connect. In that case, it may arrange and two or more thin film inductor patterns 6 may be formed so that the number of turns of a spiral may change gradually, and an inductance value may be controlled by changing the connection number and the connection section.

[0035]

[Effect of the Invention] This invention can shorten extremely the die length of the bonding wire which connects a semiconductor laser component, an impedance matching circuit and a semiconductor laser component, and a bias circuit by forming the loading section of a semiconductor laser component, the impedance matching circuit for taking the impedance matching of the input signal to a semiconductor laser component, and the bias circuit for impressing bias voltage to a semiconductor laser component in the top face of an insulating substrate, and forming the earth electrode in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate. The inductance and stray capacity of a bonding wire which affect transmission of a high frequency signal can be stopped by this to the minimum, and it will become suitable as a wiring substrate which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in a wiring substrate, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be constituted.

[0036] Moreover, this invention is desirable, and since an earth electrode is formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern is formed with a sufficient precision by the photolithography method etc. when the bias circuit contains the thin film inductor pattern and the part of an insulating substrate in which the thin film inductor pattern was formed is thinner than others, the small thing of the variation in an inductance value is made. Furthermore, since the part of an insulating substrate in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern was formed is thinner than others, an earth electrode can stop small the stray capacity produced with a thin film inductor pattern. Furthermore, since it is formed in the top face of an insulating substrate with the thin film, if a thin film inductor pattern is the top face of a thin film inductor pattern, wirebonding of it can be carried out anywhere, as a result, it can adjust an inductance value easily, and adjustment variation can make it small and it can adjust it.

[0037] Thus, this invention can adjust an inductance value with a sufficient precision, and since it serves as a wiring substrate which stopped stray capacity to the minimum, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to a wiring substrate suitable as submounting in which the semiconductor laser component used for a semiconductor laser module is carried.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Conventionally, in an optical communication type, it is used in order for a semiconductor laser module to carry out electric - light conversion of the electric data signal which should be transmitted and to transmit to an optical fiber etc. as a lightwave signal, and a thing with the bit rate of the data communication exceeding 1G (G) bits per second (bps) is used increasingly widely.

[0003] An example of the electrical equivalent circuit of the semiconductor laser component periphery of a semiconductor laser module is shown in drawing 2 . In drawing 2 , the impedance matching circuit for adjusting the impedance of the driving signal (AC signal) with which 1 is inputted into a semiconductor laser component and a is inputted into a semiconductor laser component, and b are bias circuits which impress bias voltage to a semiconductor laser component, and lead to DC (direct current) drive power source for carrying out an excitation oscillation.

[0004] From DC drive power source, DC drive current goes into the semiconductor laser component 1 via bias circuit b, and the semiconductor laser component 1 carries out the excitation oscillation of the semiconductor laser module. Next, a RF signal is inputted into the semiconductor laser component 1 via the impedance matching circuit a, and the modulated lightwave signal is sent.

[0005] Here, if the high frequency signal inputted via the impedance matching circuit a goes into DC drive power source through bias circuit b, since supply voltage will become unstable and the oscillation of a semiconductor laser component will become unstable as a result, the stable communication link cannot be performed. For this reason, the inductor considered so that a RF signal might not go into DC drive power source is prepared in bias circuit b. As for this inductor, nothing, a winding coil, a laminating chip inductor, etc. are used in a role of the so-called choke coil.

[0006] If the semiconductor laser component 1 carries out an excitation oscillation, since it will generate heat to coincidence, the semiconductor laser component 1 is mounted in submounting which consists of a ceramic substrate with the high heat conductivity etc., and this submounting is connected to the heat sink which consists of a Cu-W alloy etc., a PERUCHIE cooler, etc. so that this heat may be missed efficiently and the semiconductor laser component 1 may be maintained at fixed temperature.

[0007] In recent years, the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed is examined by the optical-communication field. Forming the impedance matching circuit a in submounting which mounts the semiconductor laser component 1 as the one technique is examined. The impedance matching circuit a consists of signal-transmission ways, such as a microstrip line and a KOPURENA track, and a resistance element for adjustment, and, generally the characteristic impedance of a signal-transmission way is 50ohms. And the characteristic impedance of a signal-transmission way and the impedance of a semiconductor laser component in a desired frequency band are adjusted by changing thickness, such as line breadth of a signal-transmission way, and a ceramic substrate of submounting, etc., and setting up a circuit constant appropriately. Moreover, the load of the semiconductor laser component 1 is about several ohms, and it usually adjusts the resistance of the resistance element for adjustment so that the impedance of the series connection of the semiconductor laser component 1 and the resistance element for adjustment may have consistency in the characteristic impedance of a signal-transmission way.

[0008] An inductance, stray capacity, etc. which the die length of the bonding wire linked to a semiconductor laser component can be shortened, and have big effect on propagation of a high frequency signal by forming the impedance matching circuit a in the top face of the insulating substrate which makes submounting and which are produced by the bonding wire can be stopped to the minimum. Furthermore, since the impedance matching circuit a and submounting are really formed, the components mark to mount can become fewer and the small semiconductor laser module with which mounting cost was reduced can be constituted.

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EFFECT OF THE INVENTION

[Effect of the Invention] This invention can shorten extremely the die length of the bonding wire which connects a semiconductor laser component, an impedance matching circuit and a semiconductor laser component, and a bias circuit by forming the loading section of a semiconductor laser component, the impedance matching circuit for taking the impedance matching of the input signal to a semiconductor laser component, and the bias circuit for impressing bias voltage to a semiconductor laser component in the top face of an insulating substrate, and forming the earth electrode in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate. The inductance and stray capacity of a bonding wire which affect transmission of a high frequency signal can be stopped by this to the minimum, and it will become suitable as a wiring substrate which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in a wiring substrate, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be constituted.

[0036] Moreover, this invention is desirable, and since an earth electrode is formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern is formed with a sufficient precision by the photolithography method etc. when the bias circuit contains the thin film inductor pattern and the part of an insulating substrate in which the thin film inductor pattern was formed is thinner than others, the small thing of the variation in an inductance value is made. Furthermore, since the part of an insulating substrate in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern was formed is thinner than others, an earth electrode can stop small the stray capacity produced with a thin film inductor pattern. Furthermore, since it is formed in the top face of an insulating substrate with the thin film, if a thin film inductor pattern is the top face of a thin film inductor pattern, wirebonding of it can be carried out anywhere, as a result, it can adjust an inductance value easily, and adjustment variation can make it small and it can adjust it.

[0037] Thus, this invention can adjust an inductance value with a sufficient precision, and since it serves as a wiring substrate which stopped stray capacity to the minimum, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in order to be stabilized and to perform the high-speed communication link with the bit rate exceeding about 2.4Gbps, there was a problem that it was inadequate just to improve the impedance matching circuit a. That is, it is because it is impossible to prevent effectively that the frequency of the high frequency signal inputted into semiconductor laser becomes higher with increase of a bit rate, and a high frequency signal flows into DC drive power source by the inductor (choke coil) of bias circuit b. When the RF signal flowed into DC drive power source, supply voltage became unstable, the oscillation of semiconductor laser also became unstable as a result, and there was a problem that it could not communicate with a higher bit rate.
[0010] Although the inductor component was exchanged and the inductance value was adjusted to the optimal thing so that it might generally function as a choke coil on the frequency to be used, there was a problem that the adjustment was difficult, by the semiconductor laser module exceeding 2.4Gbps.
[0011] Furthermore, the inductor components used for bias circuit b were small components, and since they needed to mount these with a sufficient location precision and needed to assemble a semiconductor laser module, workability is bad, the yield did not go up but they also had the problem of forming high cost.
[0012] Therefore, this invention is completed in view of the above-mentioned situation, and the purpose is a wiring substrate suitable as an object for submounting of a semiconductor laser module which is stabilized and performs the high-speed communication link of the bit rate exceeding about 2.4Gbps, and is to offer what really formed the impedance matching circuit and the bias circuit by thin film coating technology.

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MEANS

[Means for Solving the Problem] The wiring substrate of this invention is characterized by forming the loading section of a semiconductor laser component, the impedance matching circuit for taking the impedance matching of the input signal to said semiconductor laser component, and the bias circuit for impressing bias voltage to said semiconductor laser component in the top face of an insulating substrate, and forming the earth electrode in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate.
[0014] By the above-mentioned configuration, since this invention is the wiring substrate which really formed the loading section, impedance matching circuit, and bias circuit of a semiconductor laser component in the top face of an insulating substrate, it can shorten the bonding wire which connects a semiconductor laser component and an impedance matching circuit, and the bonding wire which connects a semiconductor laser component and a bias circuit. Consequently, the effect of the inductance by the bonding wire which is easy to affect a high frequency signal, or stray capacity can be suppressed to the minimum. Therefore, it will become suitable as submounting which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in submounting, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be produced.
[0015] In this invention, preferably, said earth electrode is formed only in the part which counters said impedance matching circuit of the inferior surface of tongue of said insulating substrate, said bias circuit contains the thin film inductor pattern, and it is characterized by the part of said insulating substrate in which this thin film inductor pattern was formed being thinner than others.
[0016] By the above-mentioned configuration, since this invention forms the thin film inductor pattern with a sufficient precision by the photolithography method etc., it can do the small thing of the variation in an inductance value. Furthermore, since the part of an insulating substrate in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate, and the thin film inductor pattern was formed is thinner than others and space with air with small specific inductive capacity is formed in the insulating substrate directly under a thin film inductor pattern of an insulating substrate, an earth electrode can stop small the stray capacity produced with a thin film inductor pattern. Although it is possible to thicken thickness of the whole insulating substrate as another means which makes stray capacity small, since it is decided that it will be that the thickness of an insulating substrate makes 50 ohms adjust the characteristic impedance of the signal-transmission way of an impedance matching circuit, in order to make stray capacity of a bias circuit small, thickness of the whole insulating substrate cannot be thickened.
[0017] Adjustment variation can be made small and a thin film inductor pattern can adjust it while wirebonding of it can be carried out anywhere and it can adjust an inductance value easily, if it is the top face of a thin film inductor pattern since it is formed in the top face of an insulating substrate with the thin film.
[0018] Thus, an inductance value can be adjusted with a sufficient precision, and since it becomes the wiring substrate which stopped stray capacity, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.
[0019]
[Embodiment of the Invention] The wiring substrate of this invention is explained below at a detail. It is a sectional view [in / (a) of drawing 1 , and / in (b) / the A-A' line of (a)]. [the plan of the wiring substrate of this invention] The first earth electrode with which the semiconductor laser component with which 1 was mounted in the wiring substrate, and 2 were formed in the insulating substrate, and 3 was formed in the top face, The thin film inductor pattern with which the signal-transmission way where 4 constitutes an impedance matching circuit, and 5 constitute the resistance

element for adjustment, and 6 constitutes a bias circuit, the second earth electrode with which 7 was formed in the inferior surface of tongue, and 8 are the thin-walled part of an insulating substrate 2, and a bonding wire to which 9 changes from Au etc.

[0020] In addition, the loading section of the semiconductor laser component 1 is equivalent to the part by the side of the thin film inductor pattern 6 of the first earth electrode 3.

[0021] As for the insulating substrate 2 of this invention, it is desirable that consist of at least one sort in the nature sintered compact of an aluminum oxide (aluminum 2O3), the nature sintered compact of alumimium nitride (AlN), the nature sintered compact of silicon carbide (SiC), a crystallized glass sintered compact, and the nature sintered compact of silicon nitride (Si3N4), and especially thermal conductivity consists of the nature sintered compact of alumimium nitride of 40 or more W/m-K, the nature sintered compact of silicon carbide, and the nature sintered compact of silicon nitride.

[0022] The second earth electrode 7 by which covering formation is carried out on the inferior surface of tongue of the first earth electrode 3 by which covering formation is carried out on the top face of an insulating substrate 2, the signal-transmission way 4, the resistance element 5 for adjustment, the inductor pattern 6, and an insulating substrate 2 Do by one or more sorts of thin film forming methods, such as vacuum deposition, the sputtering method, a CVD method, and plating. Pattern processing of the first earth electrode 3, signal-transmission way 4, resistance element 5 for adjustment, and thin film inductor pattern 6 is carried out by the photolithography method, the etching method, the lift-off method, etc.

[0023] The first earth electrode 3, signal-transmission way 4, thin film inductor pattern 6, and second earth electrode 7 consist of a thin film of a three-tiered structure with which the laminating of for example, an adhesion metal layer, a diffusion prevention layer, and the initiative body whorl was carried out one by one. Here, an adhesion metal layer is the point of adhesion with the insulating substrate 2 which consists of the ceramics etc., and is good to consist of at least one sort in Ti, Cr, Ta, Nb, nickel-Cr alloy, or Ta2N etc. The thickness of an adhesion metal layer has good about 0.01-0.2 micrometers. In less than 0.01 micrometers, if sticking firmly becomes difficult and it exceeds 0.2 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation.

[0024] A diffusion prevention layer is good to consist of at least one sort in Pt, Pd, Rh, Ru, nickel, a nickel-Cr alloy, or a Ti-W alloy, when preventing the counter diffusion of an adhesion metal layer and an initiative body whorl. The thickness of a diffusion prevention layer has good about 0.05-1 micrometer, and the defect of a pinhole etc. occurs and it stops easily being able to achieve the function as a diffusion prevention layer in less than 0.05 micrometers. If it exceeds 1 micrometer, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Since adhesion can also be secured when using a nickel-Cr alloy for a diffusion prevention layer, it is also possible to exclude an adhesion metal layer.

[0025] Furthermore, the thickness of the initiative body whorl which consists of Au, Cu, nickel, Ag, etc. with low resistance has good about 0.1-5 micrometers. In less than 0.1 micrometers, if it is in the inclination for electric resistance to become large and exceeds 5 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Moreover, as for Au, it is desirable to form thinly in respect of low-cost-izing with noble metals, since it is expensive. Since Cu tends to oxidize, it is good on it to cover the protective coat which consists of nickel and Au.

[0026] An insulating substrate 2 is made to flow through the first earth electrode 3 formed in the top face of an insulating substrate 2, and the second earth electrode 7 formed in the inferior surface of tongue of an insulating substrate 2 through the metallizing pattern formed in an open hole (through hole), the beer hall where the conductive ingredient was embedded, axle-pin-rake rhe SHON, and a side face, and it may be made into same electric potential so that the RF signal passing through an impedance matching circuit may be transmitted good on the other hand.

[0027] The resistance element 5 for adjustment is formed with Ta2N, a nickel-Cr alloy, and an ingredient with the high specific resistance of TaSiO2 grade. The thickness of the resistance element 5 for adjustment has good about 0.005-0.2 micrometers, and it becomes difficult in less than 0.005 micrometers for resistance to become easy to change under the effect by the surface roughness of an insulating substrate 2 a lot, and to make variation in resistance small. If it exceeds 0.2 micrometers, it will become easy to produce exfoliation with the internal stress at the time of membrane formation. Resistance can also be finely tuned with laser trimming etc.

[0028] Although the thin film inductor patterns 6 may be used as what kind of pattern as long as they are a MIANDA pattern, a spiral (curled form) pattern, etc. and are patterns which an inductance produces, they are suitable from the ability of a spiral pattern to enlarge an inductance value more. Furthermore, two or more electrodes for wirebonding may be prepared in the top face of the thin film inductor pattern 6 so that an inductor track may be made for a long time or short and an inductance value can be adjusted by the bonding of wires, such as Au. The wiring width of face of the

thin film inductor pattern 6 has desirable about 5-200 micrometers, and wiring becomes easy to go out on the way with the irregularity of an insulating substrate 2 in less than 5 micrometers. If it exceeds 200 micrometers, when really forming in a wiring substrate, while having suitable magnitude, it becomes difficult to form a thin film inductor pattern with sufficient inductance value.

[0029] Moreover, when the thin film inductor pattern 6 is a spiral pattern, an inductance value can be finely tuned by carrying out thinning of the periphery side, such as the outermost periphery, opening spacing in the thin line section, and preparing two or more wirebonding electrodes in the direction of a track at it. Thereby, an inductance value is controllable with high precision. Moreover, stray capacity produced to the thin film inductor pattern 6 can be made still smaller by preparing the thin line section.

[0030] The thin-walled part 8 of an insulating substrate 2 can form the second earth electrode 7 and insulating substrate 2 with a diamond blade etc. first by carrying out cutting removal to the middle of the thickness direction of an insulating substrate 2 after forming the second earth electrode 7 in the whole inferior-surface-of-tongue surface of an insulating substrate 2. The thickness of the insulating substrate 2 of a thin-walled part 8 has the desirable range of 1 / 3 - 4/5 of the thickness of an insulating substrate 2, and less than in 1/3, in case a wiring substrate is mounted in a semiconductor laser module, it becomes easy to be divided from a thin-walled part 8. When it exceeds four fifths, it becomes impossible to fully stop the stray capacity generated to the thin film inductor pattern 6. Specifically, the thickness of an insulating substrate 2 is about 0.2-2mm. Moreover, the cross-section configuration of the edge of a thin-walled part may be made into a taper configuration which spreads toward the inferior-surface-of-tongue side of an insulating substrate 2, without making it perpendicular to a principal plane.

[0031] This invention is a wiring substrate which is used suitable for a semiconductor laser module and which really formed the impedance matching circuit and the bias circuit in this way, and since the top face of the insulating substrate 2 which consists of ceramics etc. is adjoined by thin film coating technology and the loading section of an impedance matching circuit, a bias circuit, and a semiconductor laser component is formed in it, the die length of the bonding wire 9 which connects them can be shortened extremely. The inductance and stray capacity of a bonding wire 9 which affect transmission of a high frequency signal can be stopped by this to the minimum, and it will become suitable as a wiring substrate which constitutes the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed. Moreover, since the impedance matching circuit and the bias circuit are really formed in a wiring substrate, the components mark to mount can become fewer further and the small semiconductor laser module with which mounting cost was reduced can be constituted.

[0032] Furthermore, in this invention, since the thin film inductor pattern 6 is contained in a bias circuit and the thin film inductor pattern 6 is formed with a sufficient precision by the photolithography method etc., the small thing of the variation in an inductance value is made. Furthermore, preferably, since the part of an insulating substrate 2 in which it was formed only in the part which counters the impedance matching circuit of the inferior surface of tongue of an insulating substrate 2, and the thin film inductor pattern 6 was formed is thinner than others, an earth electrode 7 can stop small the stray capacity produced with the thin film inductor pattern 6. Furthermore, since it is formed in the top face of an insulating substrate 2 with the thin film, if the thin film inductor pattern 6 is the top face of the thin film inductor pattern 6, wirebonding of it can be carried out anywhere, as a result, it can adjust an inductance value easily, and can make adjustment variation small and can adjust it.

[0033] Thus, an inductance value can be adjusted with a sufficient precision, and since it becomes the wiring substrate which stopped stray capacity to the minimum, it will become suitable as a wiring substrate of the semiconductor laser module which a bit rate is increased more and can communicate mass data at a high speed.

[0034] In addition, this invention is not limited to the gestalt of the above-mentioned implementation, and making various change within limits which do not deviate from the summary of this invention does not interfere at all. For example, it is good also as a wiring substrate which really formed the temperature sensor which consists of Pt which prepares the electrode pad which mounts the thermistor for measuring the temperature of the semiconductor laser component 1 in the top face of an insulating substrate 2, or measures the temperature of the semiconductor laser component 1. Moreover, the field in which the lens of the shape of a ball which condenses the lightwave signal oscillated from the semiconductor laser component 1 is installed may be prepared. Moreover, although one thin film inductor pattern 6 is formed in drawing 1 , more than one may be prepared and you may connect. In that case, it may arrange and two or more thin film inductor patterns 6 may be formed so that the number of turns of a spiral may change gradually, and an inductance value may be controlled by changing the connection number and the connection section.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The example of the gestalt of operation is shown about the wiring substrate of this invention, and it is the sectional view of a wiring substrate [in / (a) and / in (b) / the A-A' line of (a)]. [the plan of a wiring substrate]
[Drawing 2] It is the representative circuit schematic of a semiconductor laser module.
[Description of Notations]
1: Semiconductor laser
2: Insulating substrate
3: The first earth electrode
4: Signal-transmission way
5: The resistance element for adjustment
6: Thin film inductor pattern
7: The second earth electrode
8: Thin-walled part

[Translation done.]